United States Department of Agriculture
Forest Service
Arizona Zone Entomology and Pathology
2500 S. Pine Knoll Dr.
Flagstaff, AZ 86001
FAX: (520) 556-2130
Voice: (520) 556-2073

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Route To:
Subject: Southwestern Region Risk Map Products
To: Lowell Lewis

Enclosed are three documents concerning the Risk Map as requested. These documents include a table indicating treatable acres by agent, a narrative, and a list of risk functions. While we didn't enclose a map, our mortality treatment map would be identifical to the current mortality map since we identified treatments for each agents. If you have any questions please contact me at Jill Wilson/R3/USDAFS@FSNOTES or (520) 556-2074.

/s/ Jill L. Wilson

JILL L. WILSON
Entomologist

cc:
Leonard Lucero
Doug Parker
Deb Allen-Reid
John Anhold
Joe Lewis

E&P:J.Wilson:jw:6/29/00:(520)556-2074
Concur:J. Anhold: 6/30/00

SOUTHWESTERN REGION TREATMENT TABLE
June 30, 2000

Prepared by J. Wilson
Reviewed by J.Anhold, D.Allen-Reid, T.Rogers, D.Conklin, M.Fairweather, B.Fitzgibbon

AGENT	ACRES AT RISK	ACRES TREATMENT AVAILABLE	ACRES NO TREATMENT	TREATMENT DESCRIPTION
Dwarf Mistletoe	329,000	329,000	0	Silviculture Regeneration Cuts Intermediate cuts
Root Disease	69,000	69,000	0	Silviculture Regeneration Cuts Intermediate Cuts
Ips Bark Beetle	101,000	101,000	0	Silviculture Intermediate cuts
Western Pine Beetle	121,000	121,000	0	Silviculture Intermediate Cuts
Roundheaded Pine Beetle	41,000	41,000	0	Silviculture Intermediate Cuts
Mountain Pine Beetle	41,000	41,000	0	Silviculture Intermediate Cuts Regeneration cuts
Spruce Beetle	56,000	56,000	0	Silviculture Regeneration Cuts Intermediate Cuts Suppression Trap Tree
Western Spruce Budworm	21,000	21,000	0	Silviculture Intermediate Cuts Regeneration Cuts

				Insecticide Bt

R3 Risk Functions

Prepared by J.Wilson
Reviewed by J.Anhold, D.Allen-Reid, T.Rogers, D.Conklin, M.Fairweather, B.Fitzgibbon.

June 30, 2000

Western Spruce Budworm

R3 Risk Map Functions
WSBWgl=f [host, historic locations with moderate to severe defoliation**
* host = white fir, Douglas-fir, corkbark fir, spruce
WSBWmort=f [(host, historic locations with moderate to severe defoliation) x reducing factor 0.02]
*host = white fir, Douglas-fir, corkbark fir, spruce ** based on aerial survey

Other existing rating systems:
USDA Forest Service 1985. Defoliators In: USDA Forest Service Southwestern Region, FSH 2409.26a, Cutting Methods Handbook, 51.1-52.9.
WSBWsusceptibility = f [spp. composition, stand density, height class structure, Vigor, maturity, site climate, regional climate, surrounding host type]

Western Pine Beetle

R3 Risk Map Functions
WPBmort = f [(host, historic incidence) x reducing factor (0.05)]
*host = ponderosa pine

Other existing rating systems:
No published rating systems

Roundheaded Pine Beetle

R3 Risk Map Function
RPB mort = f [host, historic incidence) x reducing factor (0.10)]
Host =ponderosa pine

Other Rating Systems:
Negron, J. 1997. Estimating probabilities of infestation and extent of damage by the roundheaded pine beetle in ponderosa pine in the Sacramento Mountains, New Mexico. Canadian Journal of Forest Research. 27: 1936-1945.

POI*= f [ponderosa pine growth last 5 years, percent basal area ponderosa pine, ponderosa pine basal area, ponderosa pine mean dbh]
* where POI stands for probability of Infestation

Pipo BA killed = f [initial ponderosa pine basal area]

Negron, J., J.L. Wilson, J.A. Anhold 2000. Stand Conditions Associated with Roundheaded Pine Beetle (Coleoptera: Scolytidae) Infestations in Arizona and Utah. Environmental Entomology 29: 20-27.

POI = f [ponderosa pine periodic growth rate, ponderosa pine basal area]

Pipo BA killed = f [initial ponderosa pine basal area]

Mountain Pine Beetle

R3 Risk Map Function
MPBmort = f [host, historic incidence in Arizona]
*host = ponderosa pine

Other Rating Systems:
Stevens, Robert E., W.F McCambridge, and C.B. Edminster 1980. Risk Rating guide for Mountain Pine Beetle in Black Hills Ponderosa Pine. USDA Forest Service Research Note RM-385. 2 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Risk = f [stand structure, average stand diameter, stand density]

Schmid, J.M. S.A. Mata, and R.A. Obedzinski. 1994. Hazard Rating Ponderosa Pine Stands for Mountain Pine Beetle in the Black Hills. USDA Forest Service Research Note RM-529. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 4 pp.

Hazard = f [mean stand diameter, stand density, and spacing]

Ips

R3 Risk Map Function:
IPSmort = f [(host, historic incidence) x 0.05]
*host = ponderosa pine

Other Functions:
No rating system available

Spruce Beetle

R3 Risk Map Function
Sbmort= f [(host, expert knowledge) x 0.10]
*host = Engelmann spruce

Other Functions:
Schmid, J.M. and R.H. Frye. 1976. Stand Ratings for spruce Beetles. USDA Forest Service Research Note RM-309, 4 pp. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

White Pine Blister Rust

R3 Risk Map Function
WPBRspcns = f [range of host in Sacramento, white and Capitan mountains, reducing factor (25 percent)]

Other Rating Systems:
Geils, Brian W., D.A. Conklin, and E.P. Van Arsdel. 1999. A preliminary hazard rating model of white pine blister rust for the Sacramento Ranger District, Lincoln National Forest. USDA Forest Service Research Note RMRS-RN-6. 6 pp. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hazard = f [elevation, plant association, topographic position]

Southwest Dwarf Mistletoe

SWDMgl = f [host x reducing factor (0.13)]
* host = ponderosa pine
SWDMmort = f [host x reducing factor (0.03)]

Other Functions
None

Douglas-fir Dwarf Mistletoe

DFDMgl = f [host x reducing factor (0.13)]
* host = Douglas-fir
DFDMmort = f [host x reducing factor (0.03)]

Other Functions
None

Root Disease

Rdmort = f [(spruce-fir, mixed conifer forest types) x reducing factor (0.10)]

Other Functions
None

Region 3 Risk Map Narrative

Prepared by Jill Wilson (R3 Coordinator), Mary Lou Fairweather, Bobbe Fitzgibbon, Deb Allen-Reid, Terry Rogers, Dave Conklin
Revised 6/28/2000

General

Nine insects and pathogens of importance to the Southwest are depicted on the National risk maps including: western spruce budworm (growth loss, mortality), western pine beetle (mortality), roundheaded pine beetle (mortality), mountain pine beetle (mortality), Ips spp. (mortality), spruce beetle (mortality), southwestern dwarf mistletoe (growth loss, mortality), Douglas-fir dwarf mistletoe (growth loss, mortality), root diseases (mortality) and white pine blister rust (special concerns). These layers have been refined and updated several times. The latest version was created in January 2000. The base vegetation layer used for all layers was the 1:2,000,000 scale AVHRR layer. This layer presented us with some significant difficulties because it doesn't include one of the Region's major forest types, mixed conifer.

For the insects, criteria for selecting areas at risk were based on presence of the host species, current insect activity, historic aerial survey records (dating back to 1974) and expert knowledge. Unless otherwise noted, broad areas of susceptibility were identified around areas where current outbreaks are located or where expert knowledge, based on historic detection surveys or other information indicates the likelihood of future activity. Within those broad areas the area that would be expected to experience 25 percent or greater mortality was represented by randomly selecting a proportion of the area. It is important to note that in most cases the highlighted portions are not spatially explicit, they are a representation of the area entomologists believe are at risk.

For the diseases regional survey information, presence of host species, and expert knowledge were used to identify areas at risk. As with the insect layers broad areas, generally where susceptible host species are present, were delineated first and within those areas the area where mortality levels could be expected to exceed 25 percent was represented by selecting a random percentage of the area.

Western spruce budworm

The western spruce budworm, *Choristoneura occidentalis*, is a widespread defoliator of true firs, Douglas-fir and spruce in the Southwest. Defoliation is almost chronic in the mixed conifer forests in some places in the region. The areas delineated for the western spruce budworm risk layer were obtained from aerial detection survey maps since frequently the same areas are affected time and time again with each outbreak. In both New Mexico and Arizona, the areas at risk are located in the mixed conifer and spruce-fir forest cover types. Areas delineated are those where repeated moderate to heavy defoliation has been observed over the years. In New Mexico, this insect is currently at endemic levels in these areas, however outbreak development can be anticipated in the near future. In association with that outbreak, growth loss is expected to exceed 25% in 15 years with some mortality occurring to heavily suppressed and/or diseased trees. Populations of western spruce budworm in Arizona are at outbreak levels in the Chuska Mountains on the Navajo Reservation. Expected growth loss and mortality

would be similar to that in New Mexico if the outbreak persists for multiple years. In the White Mountains and on the San Francisco Peaks insect populations are currently at endemic levels, however, could increase to outbreak levels for multiple consecutive years during the period. No mortality, meeting the definition described for this project, is anticipated in these areas however.

Western pine beetle

The western pine beetle, *Dendroctonus brevicomis*, affects pine forests throughout the Southwest. At the present time there are no ongoing outbreaks of this insect, however with two consecutive drought years activity is expected to increase. Any condition that results in excessive demand for moisture, such as tree crowding, competing vegetation, or any condition that reduces the ability of the roots to supply water to the tree, such as mechanical root damage, root disease, soil compaction, or drought can cause moisture stress and increase susceptibility to attack (Demars and Roettgering 1982). No stand based risk rating systems have been developed for this insect. Areas outlined for the risk map were obtained from aerial detection survey records and display general areas where mortality has been caused by this insect since surveys were initiated. Though past activity is not as good a predictor of future activity with bark beetles as with budworm, we do observe that over the years certain areas have experienced repeated mortality in association with drought. Further we don't know of any areas that have had such severe mortality that we would pull them out of consideration for this exercise. Because it is impossible to pinpoint exact areas where mortality will occur in the future we estimated that 5 percent of the overall susceptible area could experience 25 percent or greater tree mortality. That 5 percent was randomly distributed throughout the generally susceptible type.

Roundheaded pine beetle

Roundheaded pine beetle, *Dendroctonus adjunctus*, is another bark beetle species affecting ponderosa pine stands in the Southwest. In New Mexico, the most recent outbreak and past outbreaks in the 1950's, 60's, and 70's have resulted in extensive areas of ponderosa pine mortality in the Sacramento mountains. In Arizona, two outbreaks have been recorded in the Pinaleno mountains in southeast Arizona, in the 1960's and more recently in the early 90's. In the recent outbreak, mortality rates approached 50 percent in affected stands (Wilson 1996) but extensive suitable host type still exists. Outbreaks seem to develop on poorer sites and ridgetops (Massey et al 1977). Negron (1997) reports that stands attacked by the roundheaded pine beetle in the Sacramento Mountains exhibit poorer growth, more abundant host type, and smaller average diameter when compared to uninfested stands. Negron et al (2000) reports that stands attacked by this insect in the Pinaleno Mountains exhibit poorer growth and more abundant host type than uninfested stands. While no large areas of mortality exist at the present time, we anticipate outbreak development will occur again within the next 15 years. The areas outlined for this insect were obtained from aerial survey records, and expert knowledge. Broad areas of susceptibility were identified based on presence of the host and historic activity and then a percentage of that area was selected to represent the area that could sustain 25 percent or greater mortality. For most of the areas outlined we estimated that 10 percent of the susceptible area could sustain 25 percent mortality. However in areas depicted in southwestern New Mexico 100 percent of the polygons are expected to experience 25 percent or great mortality where extensive needle cast caused by the *Lophodermella cerina* fungus was picked up during aerial surveys in 1999.

Mountain pine beetle

In the Southwest, the main host for the mountain pine beetle, *Dendroctonus ponderosae* is ponderosa pine, however white pines are also infested. Two rating systems have been developed for this insect in ponderosa pine in the Black Hills of South Dakota. Stevens et al (1980) reported that the three stand characteristics affecting susceptibililty to beetle attack were 1) stand structure 2) average diameter of the ponderosa pine component, and 3) stand density as expressed by average basal area per acre. Schmid et al (1994) report that in even age ponderosa pine stands in the Black Hills can be rated for infestation by the mountain pine beetle on the basis of mean stand diameter, stand density and spacing. No rating systems have been developed for ponderosa pine in the Southwest. Areas delineated for mountain pine beetle for the risk map are based on presence of the host, aerial survey records, and professional knowledge. The largest and most significant outbreaks to date have occurred on the Kaibab Plateau in northern Arizona. The last significant outbreak occurred there in the 1970's (Parker and Stevens 1979).

Ips spp.

Several species of Ips occur in the Southwest, some of the more important species in ponderosa pine include *Ips pini* and *Ips lecontei*. Areas outlined for this insect were based on aerial survey records. Ips outbreaks are often very closely tied to drought episodes and can be exacerbated by stand conditions and presence of fresh pine debris such as that created during timber harvest activities, construction, or natural events (ice storms, heavy snows, wind etc.). In outlining areas at risk to Ips, we first identified larger areas that have historically sustained significant Ips related mortality. We then randomly selected a subset of that area, 5 percent of the overall, to represent the area that could experience 25 percent or great mortality in the next 15 years.

Spruce beetle

Spruce beetle has a limited distribution in the Southwest as does its host, Engelmann spruce. Within the spruce-fir type however, it is one of the most important mortality agents in the Region. Outbreaks are associated with mature spruce-fir stands and are often precipitated by blowdown events. Areas delineated for the spruce beetle risk layer are based on current populations and expert knowledge. Spruce beetle populations are currently epidemic in the Pinaleno Mountains in southeast Arizona. Other areas with suitable stands and the potential for future activity were also identified.

White Pine Blister Rust

White pine blister rust is a very damaging, non-native fungal disease that affects southwestern white pine on the Lincoln National Forest and the adjacent Mescalero Apache Indian Reservation in southern New Mexico. The disease occurs throughout most of range of southwestern white pine in this area, which includes roughly one-half million acres of mixed-conifer and ponderosa pine cover types. While this agent is not expected to cause 25 percent or greater tree mortality on a stand basis, it is a serious threat to southwestern white pine in the Southwest and so is depicted on the special concerns map.

Southwestern Dwarf Mistletoe

The highlighted areas at risk are based on a Regionwide Roadside Survey of southwestern dwarf

mistletoe (dm) (*Arceuthobium vaginatum ssp. cryptopodum*) infection of ponderosa pine, conducted in the 1980's in Arizona and New Mexico (Maffei et al 1087). Thirteen percent of the ponderosa pine type across the region appears to be heavily infected with this dwarf mistletoe (more than two-thirds of the host trees are infected). Only heavily infected areas are expected to incur more than 25 percent growth loss in 15 years. However, because the exact locations of these areas at this scale cannot be mapped, the percent of heavily infected acres in the region was distributed randomly throughout the range of the host. In addition, 25 percent of the 13 percent (or approximately 3 percent of the total area) is allocated to mortality since this agent does kill trees when infection levels are high.

Douglas-Fir Dwarf Mistletoe

Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) is the most prevalent and damaging disease agent in southwestern mixed-conifer forests. Similar to southwestern dwarf mistletoe, growth loss and mortality caused by Douglas-fir dwarf mistletoe is expected in more heavily infected areas. The 1980's Regionwide Roadside Survey did not cover Douglas-fir dm so other research information (Andrews and Daniels 1960; Hawksworth and Lusher 1956; Hawksworth 1959; Gottfried and Embry 1977; Tinnin et. al 1999) and best professional judgement was used. In some studies, the occurrence of this disease was higher than for southwestern dm while in others it was lower. The conclusion was to use the same percentages for growth loss (13 %) and mortality (3%) as for southwestern dm. In New Mexico, the base map was used to define areas with Douglas-fir forest type. Since satellite imagery used for the base map did not detect this forest type in Arizona, historic aerial detection survey data was used to define areas with Douglas-fir and this was overlaid on the base map.

Root Diseases

The most common root diseases in the Southwest are armillaria root disease caused by *Armillaria spp.* and annosus root disease caused by *Heterobasidion annosum*. Most root disease is in the spruce-fir and mixed conifer cover types, and is often associated with bark beetles or other insects. These are often referred to as complexes. Very little root disease occurs in ponderosa pine and piñon-juniper types. Since it is a very difficult task to mark actual infection centers at this scale, broader areas were delineated where there is known to be a significant amount of host type. Pixels were randomly placed through these areas to represent the infected acreage at risk of mortality (10%).

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